G58 What Is That Little Yellow Fragment? Application of Confocal Raman Microscopy in the Identification of the Means in a Case of Murder by Blunt Object

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The goal of this presentation is to report a case of homicide on a 42-year-old man who was found dead in fields around Foggia, close to a blood-stained brick. After attending this presentation, attendees will understand, in order to identify the tool used in case of homicide, the importance of analyzing and integrating the data derived from a well-detailed crime investigation, autopsy examination, and subsequent histological investigations, as well as using a new spectroscopy technique applied to microscopy called confocal Raman.

This presentation will impact the forensic science community by demonstrating how investigation and research resulted in the conclusion that the tramma to the victim was caused by several weapons.

Finding compatibility between the cause of death and the tool used is a hard daily routine task for the forensic pathologist and not easy to achieve. Often the wounds found on the corpse may be compatible with several tools, so the crime scene data might not be instrumental for the identification of the tool used. A crime scene investigation was performed by a forensic pathologist and the police who found a 42-year-old Caucasian man dead in the fields around Foggia. The corpse was lying supine on the grass, with the head fully bloodstained and bloodstained banknotes in his mouth. The head and face showed numerous blunt wounds. Close to the head the grass was covered in blood, and near the corpse was a brick measuring 40x20x20cm, smeared with blood. Nothing else was found at the crime scene.

A multidisciplinary forensic approach, which included CT scan analysis, autopsy, histological investigation, and confocal Raman microscopy analysis was performed. The external examination revealed the presence of multiple lacerations of the scalp in the fronto-parieto-temporal, with several exposed fractures of the skull. Also, other lacerations of skin were shown in the face with a fracturative complex of bones. Furthermore, the neck presented multiple abrasions and purple bruises. The CT scan analysis of the head demonstrated multiple fractures of neurocranium and facial bones, in particular of the skull in the left fronto-parietal.

The autopsy examination confirmed the multiple fractures of the skull and the face, in the parieto-frontal side and the maxillary bone. The detailed examination of the skull fractures at the left fronto-parietal detected a little yellow fragment of unknown material which wasremoved for subsequent exam with confocal Raman microscopy directed to identify its molecular structure. In addition, the internal examination revealed multiple contusions of the brain, especially in the left parietal side and at frontal level. The examination of the neck revealed hemorrhagic area of sterno-cleido-mastoidei muscles, and also the fracture of the thyroid cartilage with contusion of thyroid, along with the presence of blood inside trachea. No other traumatic injuries were found. The microscopic findings were represented by polyvisceral stasis, widespread and extensive cerebral intraparenchymal hemorrhages, cytotoxic and vasogenic edema, massive pulmonary edema, acute emphysema and atelectasis, and blood aspiration. According to the crime scene data, autopsy, histological, and CT scan findings, the cause of death was attributed to multiple skull and face fractures with deep brain contusions, blood aspiration, and combined mechanism attributed to an external neck compression suggested by the fracture of the thyroid cartilage.

With regard to the blunt object used, the results of the forensic investigation pointed out that the lesions revealed on the corpse were linked to the brick found on the crime scene. However, the yellow fragment of unspecified nature, found in correspondence of the skull fracture in the left fronto-parietal, suggested that a tool other than the brick found on crime scene caused this lesion. Therefore, the fragment was analyzed with the confocal Raman microscope.

The Raman spectroscopy is a technique which enabled the discovery of to discover information on the molecular composition of materials and, then, to identify their nature. This technique is based on the diffusion of a monochromatic radiation incident on the surface of an object, which can be absorbed, reflected, or diffused, and it is an ideal tool for identifying and distinguishing between organic and inorganic molecules and crystals. Specifically, the theory behind the Raman Spectroscopy is based on the inelastic scattering of low-intensity, nondestructive laser light by solid, liquid, or gas sample. Confocal Raman microscopy combines the three-dimensional optical resolution of confocal microscopy and the sensitivity to molecular vibrations which characterizes Raman spectroscopy. In confocal Raman microscopy, the chemical composition of a sample can be imaged by recording the integrated intensity of characteristic Raman lines of the substances involved. Thus, one can investigate whether and to which degree mixtures of substances are homogeneous on the length scale of micrometers and above. Confocal Raman microscopy is a relatively new technique that allows chemical imaging without specific sample preparation. By integrating a sensitive Raman spectrometer within a state-of-the-art microscope, Raman microscopy with a spatial resolution down to 200nm laterally and 500nm vertically can be achieved using visible light excitation.

Confocal Raman Microscopy, Homicide, Blunt Object

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